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# SYNOPSIS OF BIOLOGICAL DATA ON SPRAT

Sprattus sprattus (Linnaeus) 1758

(Mediterranean and adjacent seas)

by

M. DEMIR

Hydrobiological Research Institute
Istanbul, Turkey

For

GENERAL FISHERIES COUNCIL
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## PURPOSE OF THIS SERIES

This is one of a series of synopses of biological data concerning species of aquatic organisms of economic importance. The primary purpose of this series is to make existing information readily available to fishery scientists, according to a standard pattern, and by so doing also to draw attention to gaps in knowledge. It is hoped that synopses in this series will be useful to scientists initiating investigations of the species concerned or of related ones; as a means of exchange of knowledge among those already working on the species, and as the basis for comparative study of fisheries resources.

The synopses are the output of a system for cumulative storage and retrieval of data on the biology of species and stocks, called Species and Stocks Thesaurus (SAST), maintained by the Fisheries Biology Branch of FAO. They will be brought up to date from time to time, as further information becomes available. It is, therefore, recommended that they be filed in loose-leaf folders; pagination begins anew with each chapter, so that partial revisions may be made.

Biology Branch is working to secure the cooperation of scientists in drafting synopses on species about which they have special knowledge, and welcomes offers of help in this task. Additions and corrections to synopses already issued will also be most welcome. Comments and requests for information should be addressed to the editor of this series:

Horacio Rosa, Jr.
Biology Branch, Fisheries Division
FAO, Rome, Italy

## PREPARATION OF THIS SYNOPSIS

The first draft has been prepared for presentation at the 7th Session of the General Fisheries Council for the Mediterranean, Madrid, 12-18 March 1963.

It will be revised and republished as a synopsis of the same series.

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Gives compiled information on identity, distribution, bionomics and life history, population, exploitation and a bibliography

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# 1. IDENTITY

## 1.1 Taxonomy

### 1.1.1 Definition

Phylum VERTEBRATA
Subphylum Craniata
Superclass Gnathostoma
Series Pisces
Class Teleostomi
Subclass Actinopterygii
Order Clupeiformes
Suborder Clupeoidei
Superfamily Clupeoidae
Family Clupeidae
Genus Sprattus Girgensohn 1846
Species Sprattus sprattus (Linnaeus) 1758

### 1.1.2 Description

- Genus Sprattus Girgensohn 1846

Body elongate, well compressed; head naked; trunk covered with deciduous cycloid scales; belly forming a sharp and serrate keel with distinctly keeled ventral scales; no oblong scale on the base of caudal fin; the commencement of dorsal fin nearer the base of caudal fin than the tip of snout; ventral fins originate below the commencement of dorsal fin or in front of it, but never behind it; the two hindmost rays of anal fin not elongate; no radiating lines on gill cover; upper jaw without indentation anteriorly; maxillary reaches to or slightly past the anterior margin of eye; vomer toothless.

- Sprattus sprattus (Linnaeus) 1758 (see Fig. 1)

Major morphological features described under the genus; eye rounded, somewhat large, with free lateral adipose eyelide; lower jaw slightly in advance of upper; some very small teeth in the tip parts of jaws; rudimentary teeth on tongue, none on vomer and palatines; gill-rakers slender, the longest raker distinctly shorter than eye diameter.

Color, postmortem, dusky above, silvery white below.

Depth 4.91 to 5.89, head 4.27 to 4.71, prepectoral distance 4.26 to 4.70, predorsal distance 1.89 to 2.02, preventral distance 1.92 to 2.05, preanal distance 1.43 to 1.51 in length to the fork; eye 3.43 to 4.00, interorbital 4.60 to 5.50, preorbital distance 2.67 to 3.25 in head.

D. 16 to 19, P. 16 to 18, V. 7 to 8, A. 19 to 22, C. n+19+n, gill-rakers on the first branchial arch 50 to 59 = (14 to 17) + (35 to 42), keeled ventral scales 29 to 35 = (19 to 23) + (9 to 13), vertebrae 47 to 49.

Description based on 90 to 115 mm long (LF.) specimens from the Sea of Marmara.

Meristic characteristics given by other authors are shown in Table I.

TABLE I - Meristic characteristics of sprat given by other authors.

| Author | D | P | V | A | C | K=($K_1$+$K_2$) | Gill-rak N= $M_1$+$N_2$ | Vert. |
|---|---|---|---|---|---|---|---|---|
| 1845 Cuv. and Val. | 18 | 14 | 7 | 20 | 25 | - | - | - |
| 1845 Cuv. and Val. | 18 | 14 | 9 | 18 | 25 | - | - | - |
| 1881 Moreau | 16-18 | 14 | 8 | 18-21 | 5/16/5 | - | - | - |
| 1881 Moreau | 16-18 | 14 | 7 | 18-20 | 3/17-19/4 | - | - | - |
| 1893 Carus | 16-19 | 14-18 | 7-8 | 18-21 | 3/17-19/4 | $K_2$=11-12 | - | 47-49 |
| 1906 Antipa | 16-17 | 17-18 | 7 | 19-20 | - | 29-33=( - )+(9-11 | - | - |
| 1909 Ehrenbaum | 15-18 | - | 6-7 | 19-22 | - | (20-24)+(9-13) | - | 46-50 |
| 1927 Kyle and Ehren. | 17-19 | 16-17 | 7-8 | 18-20 | x/19/x | (22-23)+11 | 47-50 | 46-49 |
| 1931 Schnakenbeck | 17-19 | 16-17 | 7-8 | 18-20 | - | $K_2$, 11 | - | 46-49 |
| 1936 Ehrenbaum | 15-18 | 16-17 | 6-8 | 19-22 | - | (20-24)+(9-13) | - | 46-50 |
| 1939 Slastenenko | 16-17 | - | 7 | 19-20 | - | 29-33=(19-22)+(9-12) | 45-56 | 46-49 |
| 1947 Lozano Rey | 16-18 | - | 7 | 17-21 | - | 32-35 | n=34-41 | 46-49 |
| 1949 Berg and al. | 16-17 | - | 7 | 19-20 | - | 29-33=(19-22)+(9-12) | 45-56 | 46-49 |
| 1952 Cărăuşu | 17-19 | 16-17 | 7-8 | 19-20 | n/19/n | 29-33=(19-22)+(9-12) | 45-56 | 46-49 |
| 1956 Slastenenko | 16-17 | - | - | 19-20 | - | 29-33 | 45-56 | 46-49 |

1.2 Nomenclature

1.2.1 Valid scientific name

Sprattus sprattus (Linnaeus) 1758

1.2.2 Synonyms

Clupes sprattus Linnaeus 1758
Clupanodon phalerica Risso 1826
Clupea phalerica Bonaparte 1845
Clupea papalina Bonaparte 1845
Harengula sprattus Cuvier and Valenciennes 1847
Spratella pumila Cuvier and Valenciennes 1847
Meletta vulgaris Cuvier and Valenciennes 1847
Meletta mediterranea Cuvier and Valenciennes 1847
Clupea schoneveldii Krøyer 1853
Engraulis meletta Cinternas 1867
Alosa papalina Canestrini 1872
Meletta phalerica Moreau 1881
Clupea sulinae Antipa 1906
Clupea pallassi Borja 1920

1.2.3 Standard common names, vernacular names See Table II.

1.3 General variability

1.3.1 Subspecific fragmentation (races, varieties, hybrids)

- Races

The Mediterranean sprat forms a distinct race from the North European sprat races (Cligny 1909, Fage 1920, Furnestin 1948), and it is distinguished from the North European races by the following characters:

The head shorter.
The dorsal and anal fins a little anterior.
The number of vertebrae increased.
The number of keeled ventral scales decreased.

Fage (1920), shows a tendency to distinguish three races, based on the mean number of keeled scales, in the Mediterranean and adjacent seas: the one in the Gulf of Lions with 32.69 mean number of keeled scales (Meletta phalerica); the second in the Adriatic Sea with 31.31 mean number of keeled scales (Clupea papalina); the third in the Black Sea with 31. 09 mean number of keeled scales (Clupea sulinae).

Stoianov (1953) states that the Black Sea sprat is different enough from the Mediterranean sprat for a nomenclature as Sprattus sprattus sulinus (Antipa). In spite of Stoianov, however, the authors from the Black Sea countries (Aksiray 1954, Aslanova 1954, Pavlovskaja 1954, Vodianitski and Kazanova 1954, Slastenenko 1956, Nikolski 1957, Porumb I.I. and F.I. Porumb 1958, Cautis 1958) use the name Sprattus sprattus phalerious (Risso) for the Black Sea sprat as the previous authors used (Slastenenko 1939, Berg et al. 1949, Carausu 1952).

TABLE II - Common and vernacular names of sprat.

| Country | Standard Common Name | Vernacular Name (s) |
|---|---|---|
| U.S.S.R. | | |
| RUMANIA | Şprot | tata, ciacia |
| BULGARIA | | |
| TURKEY | Çaça | aci çaça, platika |
| GREECE | Papalina | |
| YUGOSLAVIA | Papalina | srdjelica, srdelica, s. oliga, sarak, gavica, katarincica papalin |
| ITALY | Sarda | papalina, sarda papalina, sarda fimminodda, sarda frisca, dardellina, sardela, sorretta, saraghina, sarachina, sarachella, renga, rencheta, argentina, girnchettu, varvajolu |
| FRANCE | Sprat | sprot, esprot, melette phalerique, amelette, harenguet, ceillet, menuise |
| SPAIN | Espadin | sardina, sardineta, amploja, amploya, collaca, alatxa |
| MALTA | Sardina hadra | sardellina, lacci |

The author believes that, in the Mediterranean and adjacent Seas, there is only one sprat to distinguish nomenclaturally. This is Sprattus sprattus phalericus (Risso), the Mediterranean subspecies or geographic race of Sprattus sprattus (Linnaeus). This subspecies is not homogeneous, but is composed of various local populations, all of them differing in the mean values of various quantitative characters of the subspecies. See Tables III to VI.

- Varieties

There is no report about specimens deviating markedly from externally normal shaped sprat. Stoianov (1953), however, distinguished sprats with different type of brain in Bulgarian waters (see Figs. 2 and 3). The author believed fishes with similar brain types were hatched in similar environments and that fishes with dissimilar brain types were hatched in dissimilar environments.

- Hybrids

Natural hybridization has not been reported.

TABLE III - Distribution of vertebrae counts of sprat from different localities.

| Locality | Author | Number of fish | | | | | | | | N | M | S.D | S.E | Fl.N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 44. | 45. | 46. | 47. | 48. | 49. | 50. | 51. | | | | | |
| Gulf of Lion | Furnestin (1948) | - | - | 2 | 63 | 173 | 28 | - | - | 266 | 47.8540 | 0.5900 | 0.0362 | 0.1200 |
| Adriatic Sea | Fage (1920) | - | - | 2 | 66 | 76 | 2 | - | - | 146 | 47.5300 | 0.7200 | 0.0400 | 0.2000 |
| Sea of Marmara | M. Demir (1962) (unpublished) | - | - | 7 | 84 | 69 | 7 | - | - | 167 | 47.4551 | 0.6476 | 0.0501 | 0.1689 |
| Black Sea | Fage (1920) | - | - | 1 | 15 | 9 | 1 | - | - | 26 | 47.3800 | 0.7400 | 0.0990 | 0.4900 |
| Black Sea | Stoianov (1953) | 1 | 3 | 65 | 418 | 457 | 95 | 5 | 1 | 1045 | 47.5700 | 0.7800 | 0.0200 | - |

TABLE IV - Distribution of keeled ventral scales counts of sprat from different localities.

| Locality | Author | Number of fish | | | | | | | | | N | M | S.D | S.E. | Fl.M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 28. | 29. | 30. | 31. | 32. | 33. | 34. | 35. | 36. | | | | | |
| Gulf of Lion | Fage (1920 | - | - | - | 4 | 4 | 10 | 5 | - | - | 23 | 32.6900 | 1.0900 | 0.1570 | 0.7850 |
| Adriatic Sea | Fage (1920) | - | - | 2 | 10 | 6 | 1 | - | - | - | 19 | 31.3100 | 0.8100 | 0.1270 | 0.6350 |
| Sea of Marmara | M. Demir (1962 (unpublished) | - | 4 | 7 | 27 | 53 | 72 | 25 | 8 | 1 | 197 | 32.4924 | 1.2098 | 0.0862 | 0.2907 |
| Black Sea | Fage(1920) | - | 3 | 4 | 10 | 6 | 5 | - | - | - | 31 | 31.0900 | 1.2200 | 0.1490 | 0.7400 |
| Black Sea | Stoianov (1953) | 3 | 5 | 22 | 45 | 26 | 8 | 3 | - | - | 112 | 31.0900 | 1.1700 | 0.1100 | - |

TABLE V - Distribution of pre Ventral keeled scales counts of sprat from different localities

| Locality | Author | Number of fish | | | | | | | N | M | S.D | S.E | Fl.M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 18. | 19. | 20. | 21. | 22. | 23. | 24. | | | | | |
| Gulf of Lion | Fage (1920) | - | - | 2 | 11 | 10 | - | - | 23 | 21.3400 | 0.7300 | 0.1040 | 0.5200 |
| Adriatic Sea | Fage (1920) | - | - | 4 | 11 | 4 | - | - | 19 | 21.0000 | 0.6600 | 0.1030 | 0.5150 |
| Adriatic Sea | Stoianov (1953) | - | 2 | 6 | 36 | 28 | 2 | - | 74 | 21.3000 | 0.7600 | 0.0900 | - |
| Sea of Marmara | M. Demir (1962) (unpublished) | - | 7 | 14 | 88 | 72 | 15 | 1 | 197 | 21.9909 | 0.8837 | 0.0630 | 0.2124 |
| Black Sea | Fage (1920) | - | 6 | 9 | 12 | 4 | - | - | 31 | 20.4500 | 1.1000 | 0.1340 | 0.6700 |
| Black Sea | Stoianov (1953) | 1 | 8 | 34 | 46 | 15 | 1 | 1 | 106 | 20.6900 | 0.9300 | 0.0900 | - |

TABLE VI - Distribution of post Ventral keeled scales counts of sprat from different localities.

| Locality | Author | Number of fish | | | | | | N | M | S.D | S.E | Fl.M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 8. | 9. | 10. | 11. | 12. | 13. | | | | | |
| Gulf of Lion | Fage (1920) | - | - | 3 | 9 | 11 | - | 23 | 11.3400 | 0.7200 | 0.1030 | 0.5150 |
| Adriatic Sea | Fage (1920) | - | - | 14 | 4 | 1 | - | 19 | 10.3100 | 0.6600 | 0.1030 | 0.5150 |
| Adriatic Sea | Stoianov (1953) | - | - | 25 | 48 | 3 | - | 76 | 10.7100 | 0.5300 | 0.0600 | - |
| Sea of Marmara | M. Demir (1962) (unpublished) | - | 3 | 39 | 106 | 43 | 6 | 197 | 11.0508 | 0.7742 | 0.0552 | 0.1861 |
| Black Sea | Fage (1920) | - | 4 | 8 | 14 | 5 | - | 31 | 10.6400 | 0.9800 | 0.1200 | 0.6000 |
| Black Sea | Stoianov (1953) | 4 | 3 | 33 | 29 | 6 | - | 106 | 10.2800 | 0.7800 | 0.0800 | - |

## 2. DISTRIBUTION

### 2.1 Delimitation of the total area of distribution and ecological characterization of this area.

Sprat has been known from the following areas: the southern Sea of Azov; all the Black Sea; the Sea of Marmara, including the Bosporus and Dardanelles; the Aegean Sea; the Adriatic Sea; the European coasts of Mediterranean from easternmost Italy to the Gulf of Valencia in Spain; the Balearic Islands; the Gulf of Catania in Sicily. These areas cover the northern Mediterranean and its adjacent seas above 39° N. The waters within this range are characterized by relatively abundant plankton, low salinity, low temperature.

### 2.2 Differential distribution

2.2.1 Areas occupied by eggs, larvae and other junior stages: annual variations in these patterns and seasonal variations for stages persisting over two or more seasons. Areas occupied by adult stages: seasonal and annual variations of these

- Eggs

Though the eggs of sprat have been reported from the Gulf of Lion (Fage 1920) and from the Adriatic Sea (Graeffe 1888 and Sliasny 1910 quoted by Fage 1920), the Black Sea is the only area where the occurrence of the sprat eggs in plankton have been explored satisfactorily from many points of view.

According to Berg et al. (1949) and Vodianitski and Kazanova (1954), sprat eggs occur nearly everywhere in the Black Sea. Fig. 4 from Aslanova (1954) and Figs. 5 to 7 from Pavlovskaja (1954) show the distribution of sprat eggs based on plankton hauls in surface waters of areas that have been explored in the Black Sea in different periods.

- Larvae

The larvae of sprat have been reported only from the Black Sea (Berg et al. 1949, Vodianitski and Kazanova 1954) in the Mediterranean and adjacent seas areas. They occur in the same regions as eggs.

- Junior stages

They occur in the same areas as adults

- Adults

See section 2.1

### 2.3 Behavioristic and ecological determinants of the general limits of distribution and of the variations of these limits and of differential distribution

Temperature is the factor controlling the distribution and behavior of sprats.

The lower and upper limits of temperature tolerance appear to be 4° and 24° C. Berg et al. (1949), however, state that the schools of sprat disperse in waters with a temperature above 20 to 22° C. Aslanova (1954) and Pavlovskaja (1954) report that the reproduction of this species takes place at temperatures from 5° to 19° C, although the optimum range is 6.8° to 12.4° C. (Pavlovskaja 1954).

The salinity of waters in which the fish occurs varies between 4 °/oo and 36 °/oo. The eggs of the fish, however, occur in waters where salinity varies between 13.5 °/oo and 19 °/oo in the Black Sea (Pavlovskaja 1954).

## 3. BIONOMICS AND LIFE HISTORY

### 3.1 Reproduction

#### 3.1.1 Sexuality (hermophroditism, heterosexuality intersexuality)

Heterosexual. No externally observable characters are known to distinguish females and males.

#### 3.1.2 Maturity (age and size)

Mediterranean sprat off France and Spain reach their first sexual maturity at the end of their first year of life. Their length at the end of first year is about 100 mm (Furnestin 1948, Vives and Suau 1956).

Black Sea sprat also reach first sexual maturity at about the end of the first year, but the length reached in that stage is somewhat smaller; about 60 to 65 mm.

#### 3.1.3 Mating (monogamous, polygamous, promiscuous)

Polygamous.

#### 3.1.4 Fertilization (internal, external)

External.

#### 3.1.5 Fecundity

There are several reports on the number of eggs produced by individual Black Sea sprat. However, the number of eggs given in these reports differs greatly. For example, it is given as 600 to 2,400 by Berg et al. (1949). And Cărăuşu (1952); as 700 to 5,250 (by Stoianov (1953); as 1,022 to 31,023 by Aslanova (1954); as 398 to 575 by Slastenenko (1956).

- Relation of gonad size and egg number to body size and to age

Larger and older individuals have larger gonads and mor eggs than smaller and younger fishes. See Table VII.

- Coefficient of fecundity (see Fig. 8)

#### 3.1.6 Spawning

- Spawning seasons (beginning, end, peak)

Furnestin (1948) states that sprat spawn during winter months in the Gulf of Lion.

Vives and Suan (1956) say 'spawning lasts from December to February' in the Mediterranean off Spain.

Relying on date presented by Aslanova (1954), Pavlovskaja (1954), Vodianitski and Kazanova (1954), spawning in the Black Sea lasts nearly all year. During summer, however, spawning becomes weak. Intensive spawning takes place during cold months with a peak in January or February.

- Number of spawnings per year, frequency

According to Aslanova (1954), the eggs of sprat are spawned in seven to nine lots in the Black Sea.

TABLE VII - Number of eggs produced by Black Sea sprat of different ages and lengths from Pavlovskaja 1954).

| Months | Length of fish (mm) | Year class | Number of eggs (range) | Average number of eggs | Numbers and diameters of ova | | | | | | | | Stages of Maturity | Number of fish |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0.9 _ 1.2 | | 0.6 = 0.8 | | 0.4 - 0.5 | | 0.2 - 0.3 | | | |
| | | | | | Range | Average | Range | Average | Range | Average | Range | Average | | |
| X-XII-II | 46-76 | 1 | 1022-6650 | 3657 | 253-511 | 382 | 450-837 | 523 | 2972-3008 | 914 | 923-3969 | 2364 | VI-IV, V-VI | 13 |
| X-XII | 84-97 | 2-3 | 9971-21146 | 15918 | -1046 | 1046 | 264-2693 | 1822 | 1374-5787 | 3715 | 6621-14174 | 10431 | VI-IV, V, IV-V | 10 |
| X-XII | 101-116 | 3-4 | 14829-31024 | 22436 | 180-2941 | 1206 | -3218 | 3218 | 2783-9338 | 5590 | 8823-21180 | 15118 | VI-IV, IV-V, V | 4 |

- Induction of spawning, artificial fertilization

Temperature is the main onvironmental factor inducing the sprat to spawn.

In the Black Sea, the eggs of this fish occur where water temperatures vary from 5 to 19° C. (Aslanova 1954. Pavlovskaja 1954). The most abundant eggs occur where temperature is 6.8 to 12.4° C. (Pavlovskaja 1954).

Salinity, varys from 13.5 to 19 °/oo in waters in which the eggs occur in the Black Sea (Pavlovskaja 1954).

Artificial fertilization has not been reported.

3.1.7 Spawning grounds (Oceanic surface, bottom)

The eggs of sprat are pelagic. In the Black Sea they occur both in coastal and oceanic waters (see Figs. 4 to 7). Depth range in which they occur is from surface to 100 to 150 meters (Aslanova 1954, Pavlovskaja 1954). They are usually found near the surface or at the surface from October-November to March, and at 40 to 80 meters from April-May to September (Povlovskaja 1954).

3.1.8 Egg: structure, size, hatching type, parasites, and predators

The fertilized plaktonic egg of sprat is spherical, transparent and colorless, protected by a thin and elastic capsule (shell); the diameter of eggs caught in Black Sea plankton vary from 0.90 to 1.15 mm (Berg et al. 1949); 0.90 to 1.20 mm (Aslanova 1954); 0.90 to 1.22 mm (Vodianitski and Kazanova 1954); 0.90 mm (Slastenenko 1956); vitellus segmented and segments look like large granules (Fig.9); no oil droplet; perivitellin space narrow in the living eggs (Vodianitski and Kazanova 1954).

Main predators are plankton-feeding fishes.

3.2 Larval history

3.2.1 Account of embryonic and juvenile life (prelarva, larva, postlarva, juvenile.

- Feeding

Embryo and prelarva feeds on yolk. Postlarva and juveniles feed on small planktonic organisms.

- Rates of: development and survival

The incubation of fertilized egg lasts 4 to 5 days in the Black Sea (berg et al. 1949). Newly hatched prelarva measures nearly 2 mm (Vodiamitski and Kazanova 1954); 2 to 2.3 mm (Berg et al. 1949, Slastenenko 1956). Three-days-old larva measures 5.5 mm (Berg et al. 1949). Yolk-sac stage ends at a length at bout 6 mm and the rays of impaired fins become conspicuous in larvae longer than 10 mm (Vodianitski and Kazanova 1954). See Fig. 10)

- Periods of: development and survival

Sufficient food, suitable temperature and salinity for the development and survival of sprat larvae and juveniles are always present in the Black Sea. During autumn, winter and spring, however, sprat are formed more perfectly and more larger scales. Outside the Black Sea, these condition are found only in winter.

- Parental care

Parental care is unlikely.

- Parasites and predators

Parasitic infection of fry has not been reported. The plankton-feeding and predaceous fishes are predators.

## 3.3 Adult history

### 3.3.1 Longevity

Vives and Suan (1956) say that two year-old sprats are scarce in commercial catches in Mediterranean Spain. Furnestin (1948) states that Mediterranean sprat along the French coast attain four years, at least. Berg et al. (1949), Cărăusu (1952), Aslanova (1954), Slastenenko (1956) report that Black Sea sprat reach five years. "Stoianov (1953) and Cautis (1958) said the oldest sprat in Bulgarian and Rumanian catches were two years old. But the scale which Stoianov presents (Fig.11) as the scale of a 16-month-old fish, 10.55 cm long, seems more like the scale of a four or five-year-old fish.

### 3.3.2 Hardiness

Since sprat is a northen species it is sensitive to high temperature and salinity. Although it withstands a temperature range from 4° to 24° C. it is uneasy below 5° and above 19° C. The salinity range of the waters in which the flesh occur varies from 4 to 36 °/oo.

### 3.3.3 Competitors

All plankton-feeding fishes are potential competitors since they seize a share of the limited quantity of food. The most serious competitor is anchovy (Engraulis encrasicolus) in the Black Sea, followed by common mackerel and horse mackerel, as important competitors. Sardine and spanish mackerel are other competitors in the Sea of Marmara.

### 3.3.4 Predators

Sprat draws the appetite of all predators. In the Black Sea, serious predators a are: Scomber scombrus, Sarda sarda, Trachurus mediterraneus, Belone belone euxini, Delphinus delphis and sea gulls. Sprat is not infrequently found in the stomach of Scophthalmus maeoticus.

### 3.3.5 Parasites and diseases

Two parasitic Copepoda: Lernaeenicus sprattae (Sowerby), and Lernaeenicus encrasichola (Turton) are well-known parasites. They are reported only from the Mediterranean off Spain by Vives and Suau (1956) in the distribution areas of sprat in the Mediterranean and adjacent Seas. Former species adheres to the eye; latter, to the sprat's body. (l.c.Fig. 12).

3.3.6 Greatest size

Palombi and Santarelli (1953) state that the sprat in Italian waters reaches 15 cm. Maximum size of sprat in the Black Sea has been reported as 13 cm. by Berg et al. 1949, Cărăusu 1952, Slastenenko 1939, 1956.

3.4 Nutrition and growth

3.4.1 Feeding (time, place, manner, season)

Sprat seeks his food during the day. According to Dimov (1961), the feeding times are early morning and toward evening.

Specific feeding places and manners have not been reported.

According to Cautis (1958), sprat in Rumanian waters feed intensively all year.

3.4.2 Food (type, volume)

Sprat feed mainly upon zooplankton, especially upon copepods. The percentage of copepods in sprat stomachs has been determined as 95 percent by Vives and Suau (1956) off Spain; as 94 percent by Cautis (1958) in Rumanian waters.

Vives and Suau (1956) listed these plankton species found in sprat stomachs:

Calanus helgolandicus ?, Clausocalanus furcatus, Clausocalanus arcuicornis, Centropages typicus, Candacia armata, Candacia varicans, Candacia bipinnata, Pleuromamma robusta, Pleuromamma gracilis, Temora stylifera, Pontella Lo-Biancoi, Undella claparedei, Cithona plumifera, Corycaeus furcifer, Corycaeus sp., Oncea media, Microsetella rosea, Euterpina acutifrons, indetermined copepodes, Podon poluphemoides.

Cautis (1958) gives the following list:

Phytoplankton: Coscinodiscus, Melosira, Ceratium, Peridinium, Pediastrum.
Zooplankton: Noctiluca miliaris; Acartia clausi, Pseudocalanus elongatus, Paracalanus parvus, Calanus helgolandicus, Oithona nana, (Cyclops strenus); Podon polyphemoides, Evadne tergestina, Penilia avirostris, (Dalphnia, Bosmina, Chidorus); the larvae of Ciripedia, Lamellibranchiata, Gastropoda; (Mesopodopsis sableri).

3.4.3 Relative and absolute growth pattern and rates.

Ages and corresponding lengths have been estimated by various authors (Table VIII, Fig. 13).

TABLE VIII - Ages and corresponding lengths of Black Sea sprat given by various authors.

| Author | Ages and Lengths (cm) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Berg et al. (1949) | (2.8) | (4.8) | (7.2) | (8.3) | (9.1) |
| Cărăuşu (1952) | (2.8) | (4.8) | (7.2) | (8.3) | (9.1) |
| Stoianov (1953) | (8.5) | (9.5) | - | - | - |
| Aslanova (1954) | 67 - 69 | 80 - 85 | 92 - 97 | 101 - 109 | 114 - 117 |
| Slastenenko (1956) | (2.8) | (4.8) | (7.2) | (8.3) | (9.1) |
| Cautis (1958) | 6 - 10 | 9 - 11 | - | - | - |
| Stoianov (1960) | 5.5 - 10 (7.9) | 7.5 - 11 (9.2) | 9.5 - 12 (10.2) | - | - |

Table VIII shows that ages and corresponding lengths estimated by various authors for the sprat in the Black Sea are very different.

## 3.5 Behavior

### 3.5.1 Migration and local movements

Regular sprat migrations between distant areas in the Mediterranean and adjacent seas have not been reported. In the Black Sea, however, the movements between coastal and oceanic waters are recorded. For instance, Berg et al. (1949) report that the mass approach to shore waters takes place from April-May to August-October. Cautis (1958) states that sprat approach the Rumanian littoral during spring, when the water temperature reaches 8° C. and it retire to open sea when temperatures go above 18° C. For the most part, sprat approach Turkey's Black Sea coast during cold months. In some winters, minor numbers of sprat migrate through the Bosphorus from the Black Sea into the Sea of Marmara.

### 3.5.2. Schooling

Sprat shows the schooling instict of Clupeidae. "Nevertheless, individuals or small schools of sprat frequently join anchovy schools. Anchovy caught in the Black Sea often contain sprat. In some Turkish catches, 10 to 15 percent of the anchovies contain sprat. Berg et al. (1949) reports that schools of sprat disperse in water warmer that 20 to 22° C.

### 3.5.3. Repreductive habits

The author knows only that sprat seek waters with temperatures from 5 to 15° C.

# 4 POPULATION (STOCK)

## 4.1 Structure

### 4.1.1 Sex ratio

Vives and Suau (1956) found 44.28 percent male, 54.79 percent female in the Mediterranean off Spain. Furnestin (1948) found 0.7 percent male, 99.3 percent female in February and 16.5 percent male, 83, 5 percent female in April in the lake of Caront. Cautis (1958) found the male ratio varying between 26.7 and 41.4 percent; the female ratio varying between 58.7 to 73.3 percent in February and March of 1956 in the Rumanian waters of the Black Sea. See also Table IX.

### 4.1.2 Age composition

Vives and Suau (1956) state that sprats occurring in the Mediterranean off Spain are one and two-year-old individuals, but two-year-old sprats are scarce and the bulk of commercial catches is composed of fishes up to one year old.

According to Furnestin (1948) the sprat in the Martigues Region is composed of fishes up to at least four years old and the percentages of 1, 2, 3 year old fishes are 73.9 percent, 21.5 percent and 4.6 percent respectively.

According to Berg et al. (1949), Cărăuşu (1952), Aslanova (1954) and Slastenenko (1956), the sprat in the Black Sea is composed of fishes up to 5 years old.

Table X from Soianov (1960), shows age composition by percentage sprat in Bulgarian catches.

### 4.1.3 Size composition

Fig. 14, and Table XI show the size composition of sprat in Mediterranean and Black Sea catches made off Spain and Bulgaria.

## 4.4 Mortality, morbidity

### 4.4.1 Rates of mortality

Mortality and survival rates of sprat in Bulgarian waters are given in Fig. 15.

## 4.6 Relation of population to community and ecosystem, biological production etc.

Sprat depends exclusively on the pelagic community. It occurs most abundantly in waters with abundant plankton. Temperature, however, is the most important factor limiting the abundance of the fish in the Mediterranean and adjacent seas. Because the fish is a northern species, it is not content in a temperature higher than 20° C, and its reproduction is not fruitful at a temperature higher than 15° C.

TABLE IX - Sex ratio in sprat in catches in different localities.

| Author | Locality | Sex ratios by months | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | Sex |
| Vives and Suau (1956) | Spanish Mediterranea | 37.84<br>62.16 | 47.54<br>52.46 | 45.21<br>54.79 | 37.70<br>62.30 | 48.46<br>51.54 | 36.09<br>63.91 | 39.34<br>60.66 | 39.74<br>60.26 | 41.67<br>58.33 | - | - | - | |
| Furnestin 1948 | Lake of Caront | -<br>- | 0.7<br>99.3 | -<br>- | 16.5<br>83.5 | -<br>- | -<br>- | -<br>- | -<br>- | -<br>- | -<br>- | -<br>- | -<br>- | |
| Cautis 1958 | Black Sea | -<br>- | -<br>- | -<br>- | 40.0<br>60.0 | 28.8<br>71.2 | 34.3<br>65.7 | 33.6<br>66.4 | 41.3<br>58.7 | 40.1<br>59.9 | 41.1<br>58.9 | 37.6<br>62.4 | 26.7<br>73.3 | |

TABLE X - Age composition of sprat in Bulgarian catches (from Stoianov 1960).

| Year / Age | 1945 | 1946 | 1947 | 1948 | 1949 | 1950 | 1955 | 1956 | 1957 | 1958 | 1959 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 57.15 | 19.80 | 81.65 | 75.14 | 55.80 | 18.31 | 84.16 | 86.06 | 95.58 | 73.78 | 18.26 |
| 2 | 41.63 | 79.40 | 18.15 | 24.69 | 43.84 | 79.79 | 15.46 | 13.94 | 4.32 | 25.72 | 80.83 |
| 3 | 1.22 | 0.80 | 0.20 | 0.17 | 0.36 | 1.90 | 0.38 | - | 0.10 | 0.50 | 0.91 |

TABLE XI - Length composition by percentage of sprat in Bulgarian catches of 195

| Length cm. / Month | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 | 10.5 | 11.0 | 11.5 | 12.0 | 12.5 | n | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-III | | | | | | 0.1 | 0.4 | 3.0 | 8.6 | 26.3 | 35.3 | 19.7 | 5.4 | 0.9 | 0.2 | 0 | 0.1 | 1433 | 9.40 |
| IV | | | | | | | 0.7 | 4.1 | 11.8 | 24.4 | 30.5 | 21.8 | 5.2 | 1.4 | 0.1 | | | 1553 | 9.37 |
| V | | | | | | | 1.0 | 6.5 | 25.4 | 32.5 | 23.5 | 9.3 | 1.4 | 0.3 | 0.1 | | | 1211 | 8.99 |
| VI-VII | 0.1 | 0.1 | 0 | 0 | 0.3 | 3.8 | 5.8 | 12.1 | 31.8 | 29.5 | 9.4 | 5.4 | 1.5 | 0.1 | 0 | 0 | 0.1 | 1444 | 8.67 |
| X-XII | | | | | | | | 0.1 | 0.9 | 15.5 | 32.9 | 33.1 | 14.7 | 2.5 | 0.3 | | | 993 | 9.77 |

# 5 EXPLORATION

## 5.1 Fishing equipment

### 5.1.1 Fishing gear

Sprat have been caught by purse seine, beach seine, trap net, and gillnet in Turkish waters.

Slastenenko (1956) states that the largest quantity (70 percent) of sprat has been taken by trap nets in the northwestern Black Sea. Berg et al. (1949) say that large Japanese nets, lampara, and trawl are used in Russian sprat fisheries.

### 5.1.2 Fishing boats

No special boats are used.

### 5.2.1 General geographic distribution

Sprat have been fished more or less everywhere they occur (see 2.1). The most important fishing areas, however, are the Black and Adriatic Seas. The northwestern parts of these seas appear much more productive.

### 5.2.2 Geographical ranges (latitudes, distances from coast etc.)

Sprat fishing in the Mediterranean and adjacent seas is done in coastal water. In the Black Sea they are usually fished not more than 10 to 15 miles offshore, often much closer.

### 5.2.3 Depth range

From 5 to 10 m, to 80 to 100 m.

## 5.3 Fishing seasons

### 5.3.1 General pattern of fishing season

Palombi and Santarelli (1953) state that Italian sprat fisheries go on all year but important fisheries take place in from March to May and September to November.

The Black Sea sprat fisheries operate year round. Intensive fishing is done in Soviet waters from April-May up to August-October, (Berg et al. 1949). Fishing in the Turkish waters of the Black sea is from October-November to May-April; ring winter and early spring in the Sea of Marmara.

## 5.4 Fishing operations and results

### 5.4.1 Selectivity

Fine-meshed nets are used. In the Black Sea and the Sea of Marmara, however, they have been caught usually with anchovy, and less frequently, with Atherina, in Turkish waters. In these cases they are selected by fishermen.

### 5.4.3 Catches

According to Cărăuşu(1952), total Black Sea sprat catch varies from between 1.300 to 3,200 metric tons per year. Stoianov (1960) gives these 1959 catch figures:

| | | |
|---|---|---|
| U.S.S.R. | 2,575 | metric tons |
| Rumania | 1,441 | " " |
| Bulgaria | 1,775 | " " |

SYNOPSIS OF BIOLOGICAL DATA ON SPRAT - N. DEMIR

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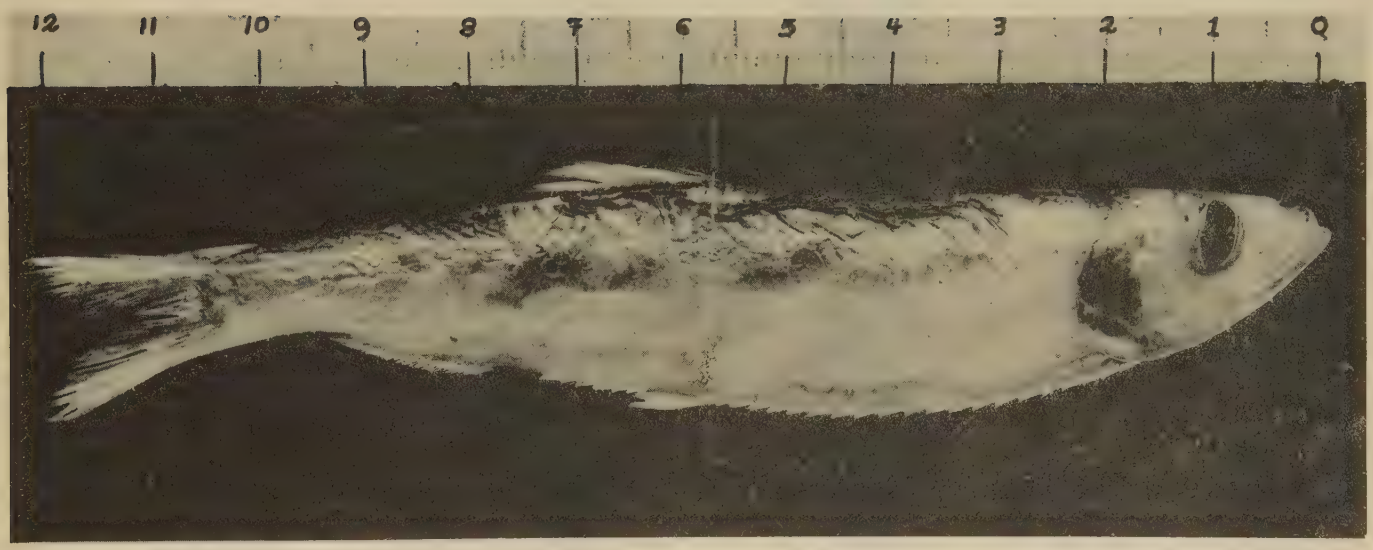
Appendix

# FIGURES




Sprat, from the Gulf of Erdek

Fig. 1 - Engraulis encrasicolus from the Sea of Marmara (Total length - 130 mm).

Fig. 2 - Brain types of sprat with two appendix on the cerebellum (from Stoianov 1953).

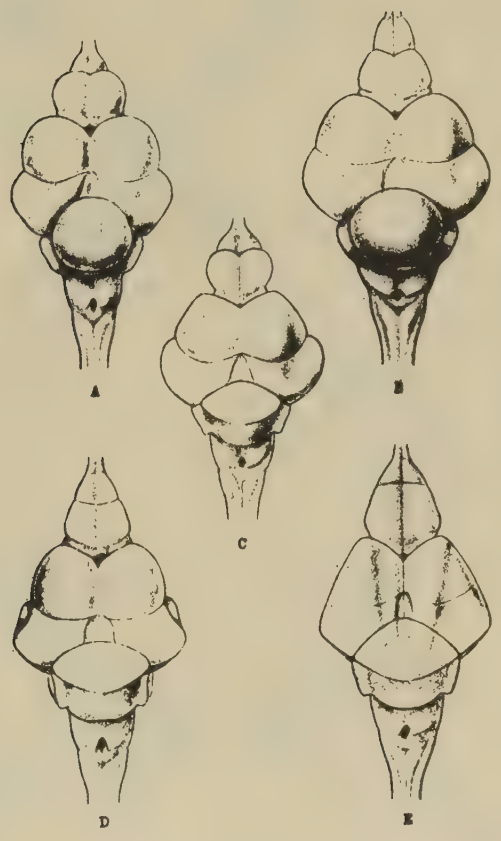



Fig. 3 - Brain types of sprat without appendix on the cerebellum (from Stoianov 1953).

Fig. 4 - Distribution of sprat eggs in the Black Sea, 1949-1951 (from Aslanova 1954).

Fig. 5 - Distribution of sprat eggs in the Black Sea according to surface plankton hauls in October-November, 1949 and 1951. Number of eggs per haul: 1) 1 to 25 eggs; 2) 26 to 50 eggs; 3) 51 to 100 eggs; 4) 101 to 300 eggs; 5) 301 to 500 eggs; 6) 4,000 eggs; 7) in 25 to 80 m depths in June-September; 8) negative stations, from Pavlovskaja 1954).

Fig. 6 - Distribution of sprat eggs in the Black Sea according to surface plankton hauls in December to February, 1950-51. Number of eggs per haul: 1) 1 to 25 eggs; 2) 26 to 50 eggs; 3) 51 to 100 eggs; 4) 100 to 300 eggs; 5) 301 to 500 eggs; 6) 2,500 eggs; 7) negative stations. (from Pavlovaskaja 1954).

Fig. 7 - Distribution of sprat eggs in the Black Sea according to surface plankton hauls in March-April, 1949-1950. Number of eggs per haul: 1) 1 to 25 eggs, 2) 26 to 50 eggs, 3) 51 to 100 eggs, 4) 101 to 300 eggs, 5) 301 to 500 eggs 6) 819 eggs (from Pavlovskaja 1954).

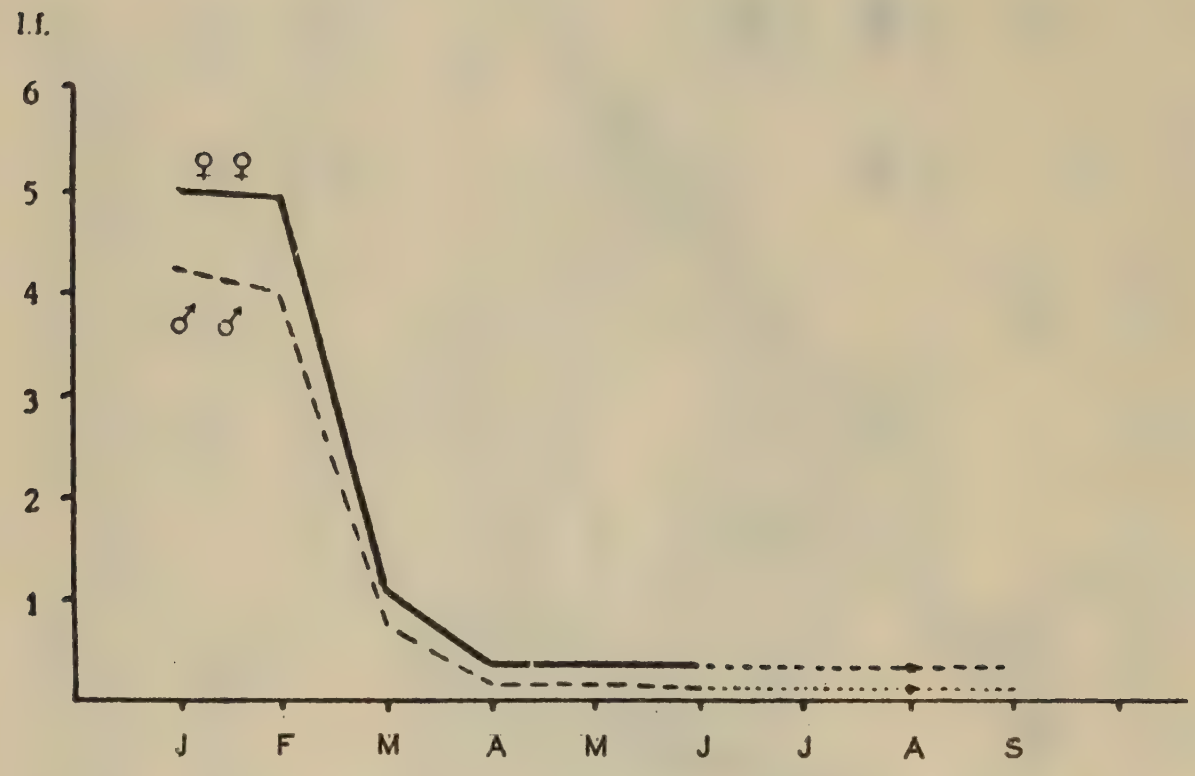



Fig. 8 - Index of fecundity of sprat in the Mediterranean off Spain (from Vives and Suau 1956).

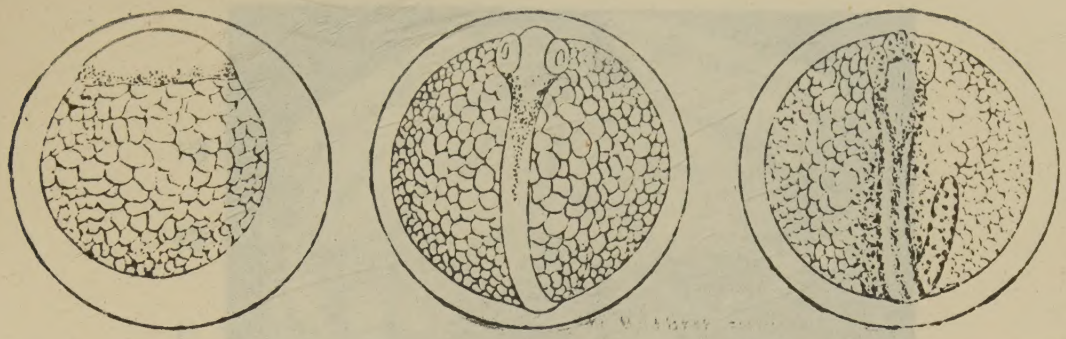


Fig. 9 - Sprat eggs with embryo in different stage of development. (from Vodianitski and Kazanova 1954).

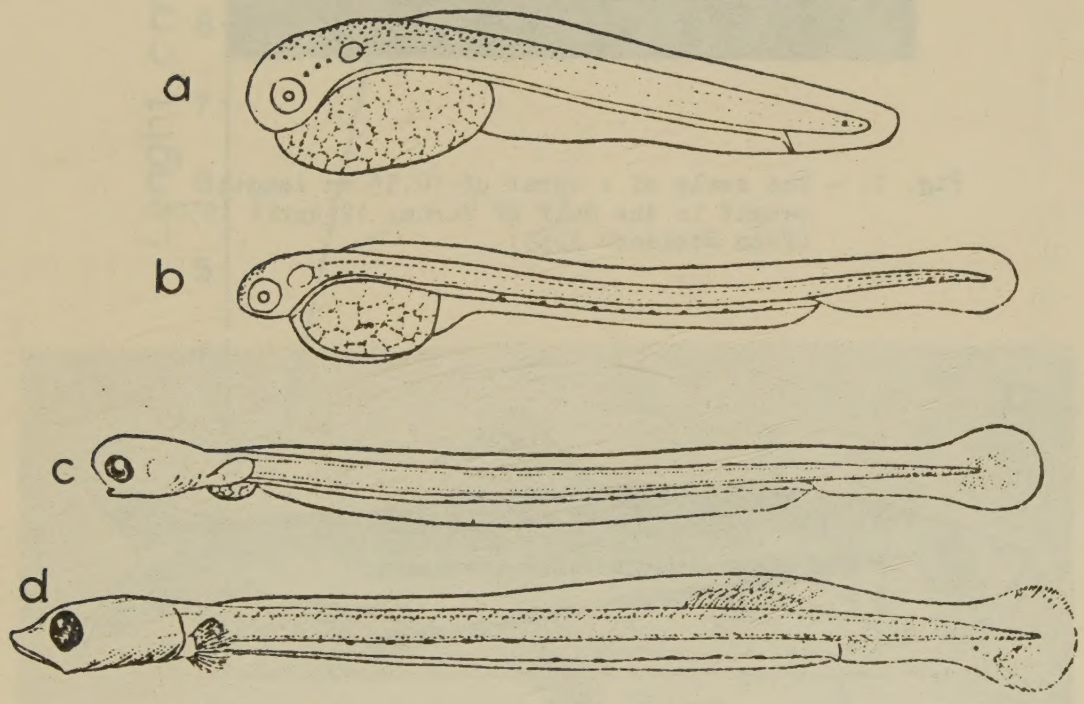



Fig.10 - Sprat larvae: a) 1.9 mm, b) 4.7 mm, c) 6.0 mm, d) 13.2 mm (from Vodianitski and Kazanova 1954).

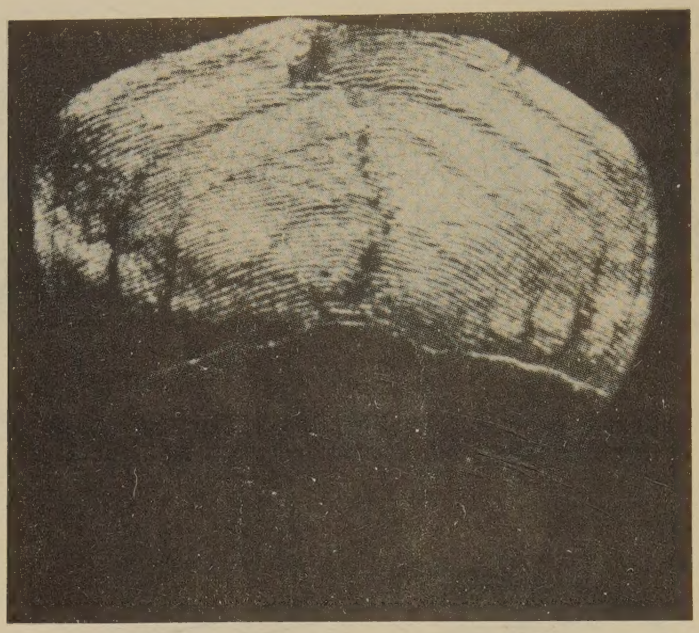


Fig. 11 - The scale of a sprat of 10.55 mm length caught in the Gulf of Varna, 12 April 1950 (from Stoianov 1953).

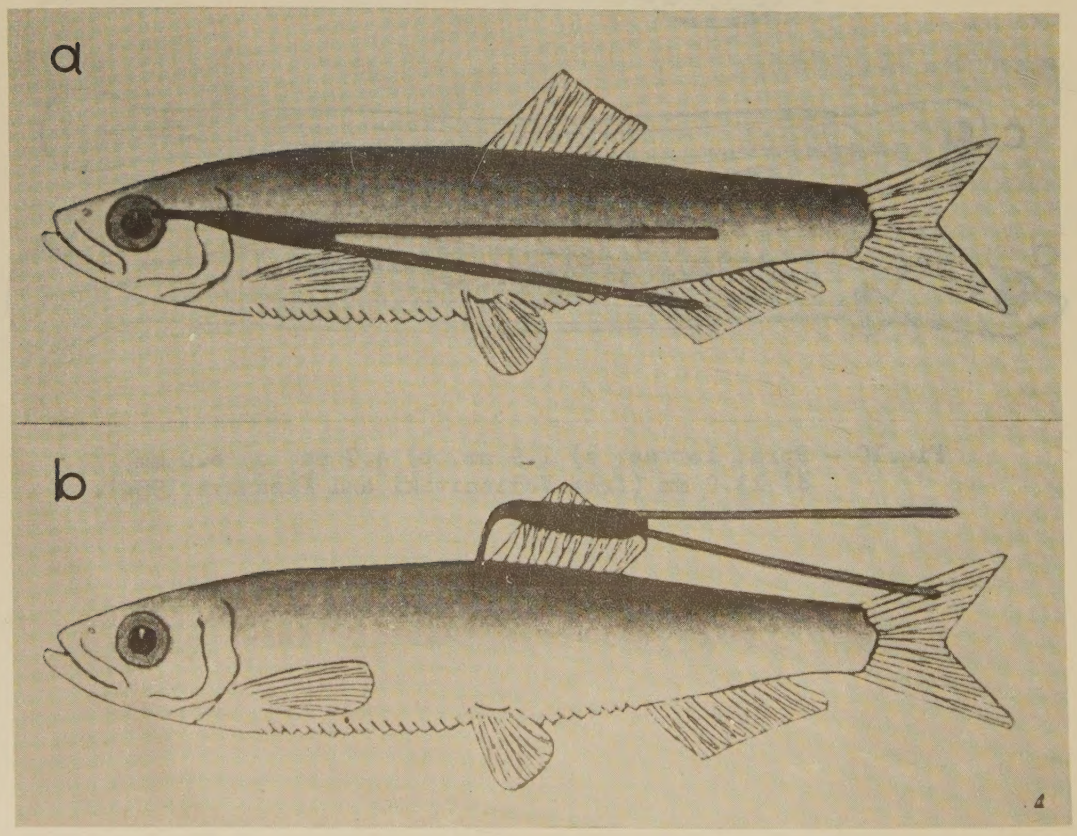



Fig. 12 - Parasitic copepodes of sprat: a) Lernaeenicus sprattae adhered to the eye, b) Lernaeenicus encrasichola adhered to the trunk before the dorsal fin (from Scot 1913).

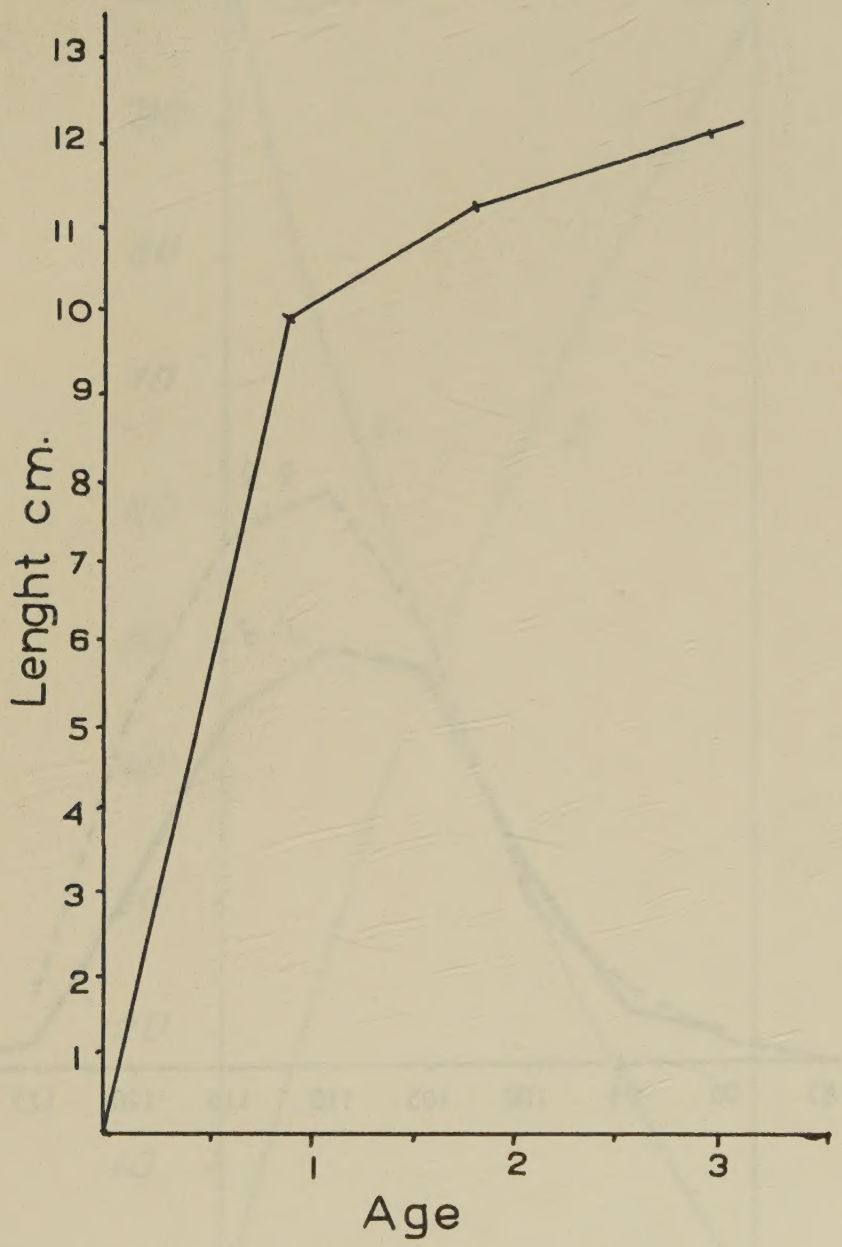



Fig. 13 - Growth curve of sprat from Martigues region of Mediterranean (from Furnestin 1948)